SiliconGraphics
Computer Systems
Onyx®
Product Guide
SiliconGraphics
Computer Systems
ONYX
Silicon Graphics
ONYX
InfiniteReality
SiliconGraphics
Computer Systems

Realistic image generation

Greater than 10 million triangles/sec

Greater than 800 million textured, anti-aliased pixels/sec

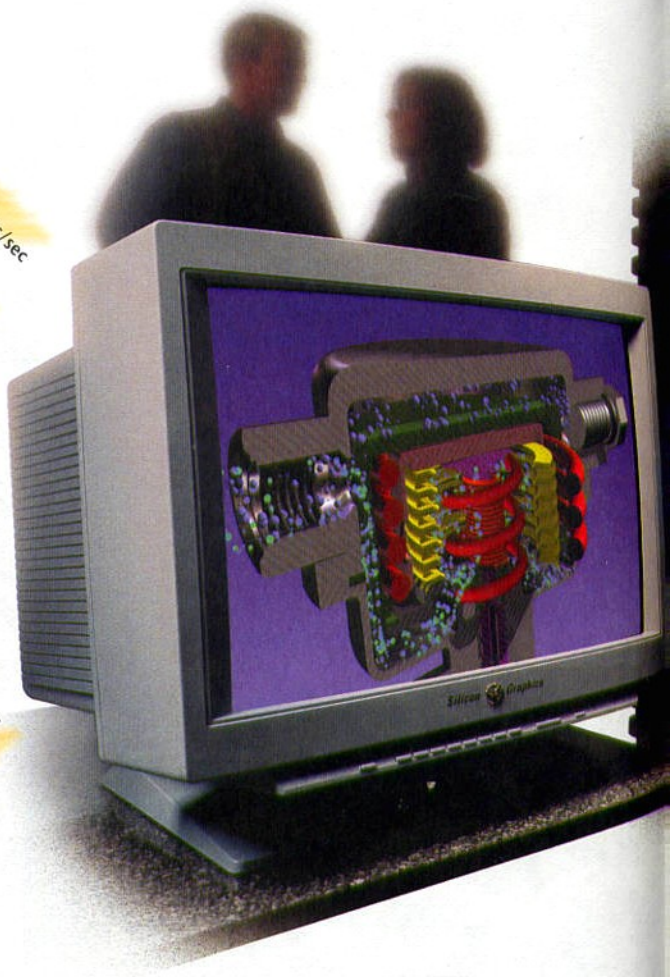
16 or 64MB texture memory, texture paging, and geospecific texture

2 GFLOPS of image processing power

Geometric warping and dynamic characters

Symmetric multiprocessing

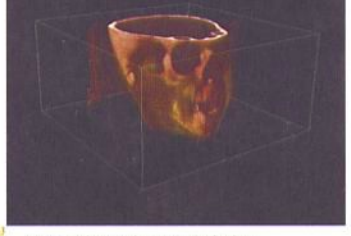
HDTV, 16-bit monochrome, and stereo display support



Digital prototyping and complex CAD visualization

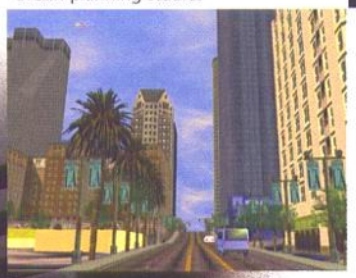
Onyx: The Visualization Supercomputer

Photo-realistic, real-time image generation; innovative broadcast virtual sets; precise image exploitation; full-size, digital, mechanical prototypes—these demanding visual computing applications push graphics, image, and video-processing requirements to their limits. Until today, you couldn't find a system that could handle all of these. With unprecedented performance levels and an incomparable, advanced feature set, the Silicon Graphics® Onyx InfiniteReality™ visualization supercomputer can concurrently process graphics, imagery, and video data while offering users real-time interactivity. This system architecture combines supercomputing performance with the world's most advanced visualization technologies.



Interactive volume rendering

Urban planning studies



Onyx
With 2 to 24 MIPS® R4400™ or R10000™ processors, Onyx combines the power of symmetric multiprocessing with high-end InfiniteReality and RealityEngine^2 graphics.

- Deskside (2-4 CPUs) or rack chassis (2-24 CPUs)
- 1-3 InfiniteReality or RealityEngine^2 subsystems in a single rack chassis
- 8-way interleaving memory: 64MB to 16GB
- Up to 68.8GB internal disk; expandable to 2TB total storage

POWER Onyx™
POWER Onyx complements the RealityEngine^2 graphics subsystem with the floating-point intensive performance of the MIPS R8000® CPU.

- Deskside (1-2 CPUs) or rack chassis (1-12 CPUs)
- 1-3 RealityEngine^2 subsystems in a single chassis
- 8-way interleaving memory: 64MB to 16GB
- Up to 68.8GB internal disk; expandable to 2TB total storage

The Onyx InfiniteReality architecture utilizes the most innovative VLSI ASIC technologies within a scalable, parallelized processing pipeline designed to combine high-quality, textured geometry processing with advanced image and video processing. This surpasses traditional graphics, making Onyx InfiniteReality the world's most powerful visualization supercomputer capable of real-time graphics, imaging, and video processing.

Second only to Onyx InfiniteReality, RealityEngine$^{2\text{™}}$ is the most successful high-performance graphics system ever designed. The RealityEngine^2 performance levels and advanced feature set established entirely new visual computing markets and applications. Next to InfiniteReality, RealityEngine^2 continues to lead the industry in advanced graphics applications.

***i*-Station and Reality Station**
In a single CPU environment, *i*-Station provides the power of an InfiniteReality pipeline, while Reality Station includes a RealityEngine^2 subsystem.

- Deskside (1 CPU)
- 1 MIPS R4400 or R10000 CPU
- 2-way interleaving memory: 64MB to 2GB
- Up to 30GB internal disk; expandable to 516GB total storage

Performance for Real-Time Interactivity

Advanced technology aircraft trainers, image exploitation systems, on-air virtual sets, and broadcast special effects—these applications demand solid frame rates. Drop a frame and you're out of the game. InfiniteReality is the only system in the world that provides performance levels to meet these demands and then extends them to other applications, including digital prototyping, medical diagnostic imaging, oil field reservoir simulation, and scientific visualization.

Feature Rich

The InfiniteReality visualization pipeline exploits parallelism in all areas and offers an innovative feature set that goes well beyond traditional graphics-processing systems.

- Bicubic, trilinear, and bilinear image filtering
- 3D textures for fully interactive volume rendering
- Texture/image download rates up to 220MB/sec
- Dynamic resolution for guaranteed frame rates
- Geospecific texture support for processing realistic geographic scenes
- Dynamic characters for creating interactive virtual actors
- Dedicated image processing support
- 16-bit monochrome support for high-quality medical and satellite images
- Support for two display channels in base configuration or up to eight display channels as an option

60Hz fly-throughs of real-world environments

Geometry Engine® Board

Four custom VLSI ASIC designs perform scaling, translating, rotations, and lighting calculations for polygons and various image-processing operations:

- 480 MFLOPS per Geometry Engine (GE11) processor
- Dedicated image-processing support for rotate, zoom, warp, convolutions, histogram transformations, min./max. operations, scaling/bias adjustments, and more
- Sirius Video interface allows live video processing
- 220MB per second interface bus offers fast access to image and geometry data stored in main system memory
- Dedicated geometric warping brings characters and virtual actors to life

Raster Manager Board

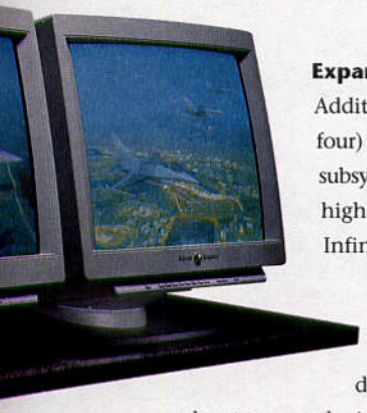
Five custom VLSI ASIC designs scan-convert output from the Geometry Engine processor into pixel data; texture/image data applied; fog color blended; multisample, anti-aliasing performed (four or eight subsamples per pixel):

- Over 200 million textured pixels per second fill rate per Raster Manager (over 800 million textured pixels per second for a four RM system)
- 80MB of frame buffer per Raster Manager board (320MB in a four RM system)
- Fast, high-quality image blends accelerate image-compositing applications
- Off-screen frame buffer memory available for multipass rendering

Dynamic characters and virtual actors

A World of Texture

To facilitate high-quality textured image generation, InfiniteReality is available with 16MB or 64MB of texture memory and supports both trilinear MIP mapping and bicubic texture filtering. For applications that demand the merging of aerial photographs with geographic terrain, geospecific texturing lets you fly continuously across vast land expanses or zoom from satellite views of the world down to the earth's surface.



Expandability to Fit Your Needs

Additional Raster Manager boards (up to four) can be installed in the InfiniteReality subsystem for increased display requirements, higher resolutions, and faster fill rates. InfiniteReality can be made even more powerful by adding broadcast-quality video input and output options (Sirius Video™) and a multiple display option. Up to three InfiniteReality subsystems can be installed in a single Onyx rack chassis for the ultimate in graphics performance.

i-Station

The perfect system for those who are seeking the ultimate in visualization processing, but whose needs don't include a multiprocessor environment, *i*-Station combines the performance of the Onyx architecture with the unbridled power of the InfiniteReality visualization pipeline.

Your eye blinks in **1/2 of a second**

The fastest jet covers a soccer field in **1/10 of a second**

Lightning strikes in **1/30 of a second**

Onyx InfiniteReality triangulates, scales, translates, rotates, lights, texture maps, blends, anti-aliases, and displays one entire high-resolution frame in

1/60 of a second

Display Generator Board

Three custom VLSI ASIC designs convert the digital frame buffer data from the raster subsystem into analog video signals:

- Bilinear filtered video resizing designed for image zooms or full-screen scan conversions
- Two display channels in base configuration support dual-screen applications or high-resolution, stereoscopic head-mounted displays
- Non-interlaced HDTV formats supported standard
- Sirius Video option provides broadcast-quality video I/O
- Various field-sequential video formats supported for advanced virtual reality head-mounted displays
- Optional Display Generator boards provide support for up to eight distinct display channels

Optimized

Each Onyx system is built around one or more 64-bit MIPS RISC microprocessors. Configured as single or multiprocessor systems, Onyx systems fully exploit the IRIX™ operating system and XFS™ filesystem to give users supercomputer performance at a fraction of the cost of a dedicated system.

MIPS R10000 Processor

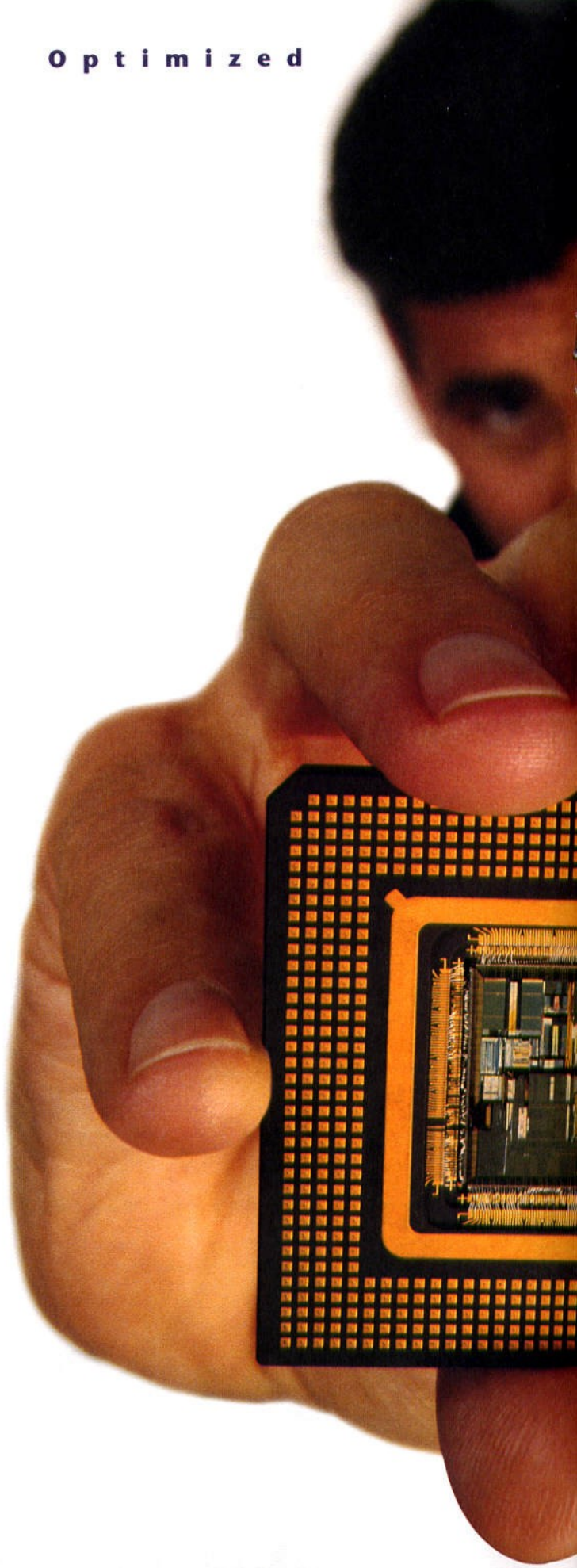
- The ultimate in integer and floating-point performance—utilized in Reality Station, *i*-Station, and Onyx
- 64-bit MIPS R10000 processor—64KB on chip primary cache; 1MB secondary cache
- One, two, or four MIPS R10000 processors per CPU board—maximum of 24 processors in an Onyx rack system

MIPS R4400 Processor

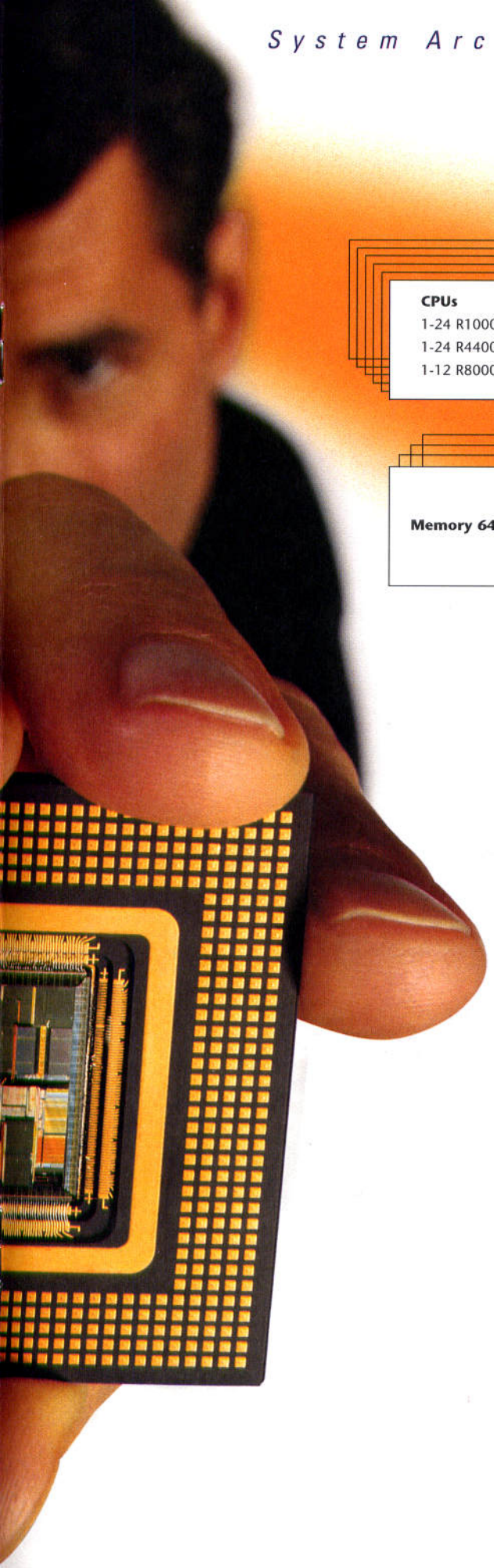
- Well-balanced integer and floating-point performance—utilized in Reality Station, *i*-Station, and Onyx
- Large cache for maximum application throughput—32KB on-chip primary cache; 1MB secondary cache with Reality Station; 4MB secondary cache with Onyx
- One, two, or four MIPS R4400 processors per CPU board—maximum of 24 processors in an Onyx rack system

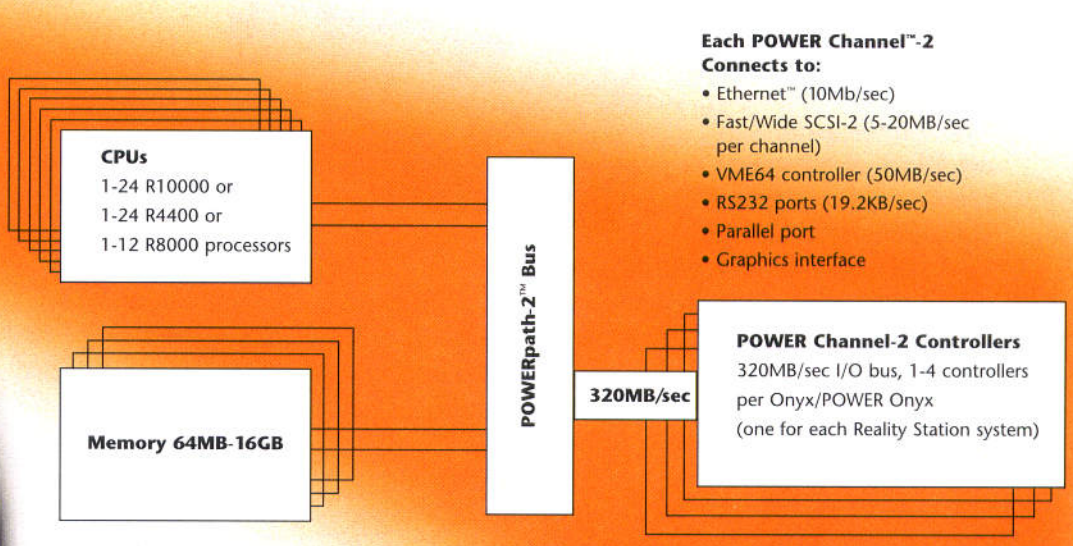
MIPS R8000 Processor

- Optimized for fast floating-point performance—utilized in POWER Onyx
- 64-bit MIPS R8000 processor—each R8000 processor is a two-component chip set consisting of an integer unit with on-board 32KB cache and a floating-point unit to deliver up to 300 peak MFLOPS per processor
- 4MB additional cache—to achieve peak application performance
- One or two R8000 processors per CPU board—maximum of 12 processors in a POWER Onyx rack system



System Architecture





Each POWER Channel™-2 Connects to:

- Ethernet™ (10Mb/sec)
- Fast/Wide SCSI-2 (5-20MB/sec per channel)
- VME64 controller (50MB/sec)
- RS232 ports (19.2KB/sec)
- Parallel port
- Graphics interface

Optional Modules Connect to:

- HIO modules for additional SCSI-2 ports
- HiPPI, FDDI, ATM network interfaces

The POWERpath™ architecture provides the throughput necessary for data-intensive applications such as satellite image acquisition and analysis, earth sciences, remote sensing, and video-on-demand.

IRIX Operating System and XFS Filesystem

The IRIX operating system, based on AT&T UNIX® System V, includes extensions such as TCP/IP network protocols, NFS™, and 4.3 BSD features. Additional extensions transparently take advantage of Onyx and POWER Onyx multiprocessing. IRIX also incorporates 64-bit operations and support for up to 16GB of memory.

XFS, a new 64-bit IRIX filesystem, offers many advanced features while retaining compatibility with NFS and existing applications. XFS supports file sizes of up to one terabyte, and extremely high, guaranteed-rate I/O performance for applications such as video-on-demand.

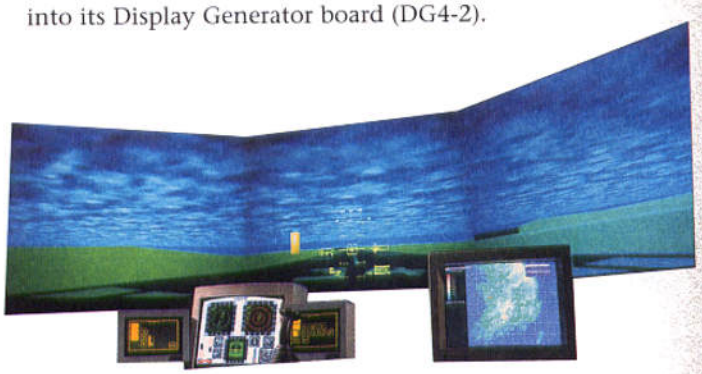
Live virtual sets

Sirius Video

The Sirius Video board converts InfiniteReality and RealityEngine^2 systems into cost-effective, general-purpose systems for video production, post-production, and broadcast television. For scientific and research applications, Sirius Video delivers full-performance video capture and manipulation, and unprecedented performance for digital image manipulation, data capture and record, and sequence playback. For advanced video applications, Sirius Video provides colorspace conversion and live video texture at real-time rates.

Multiple Channel Support

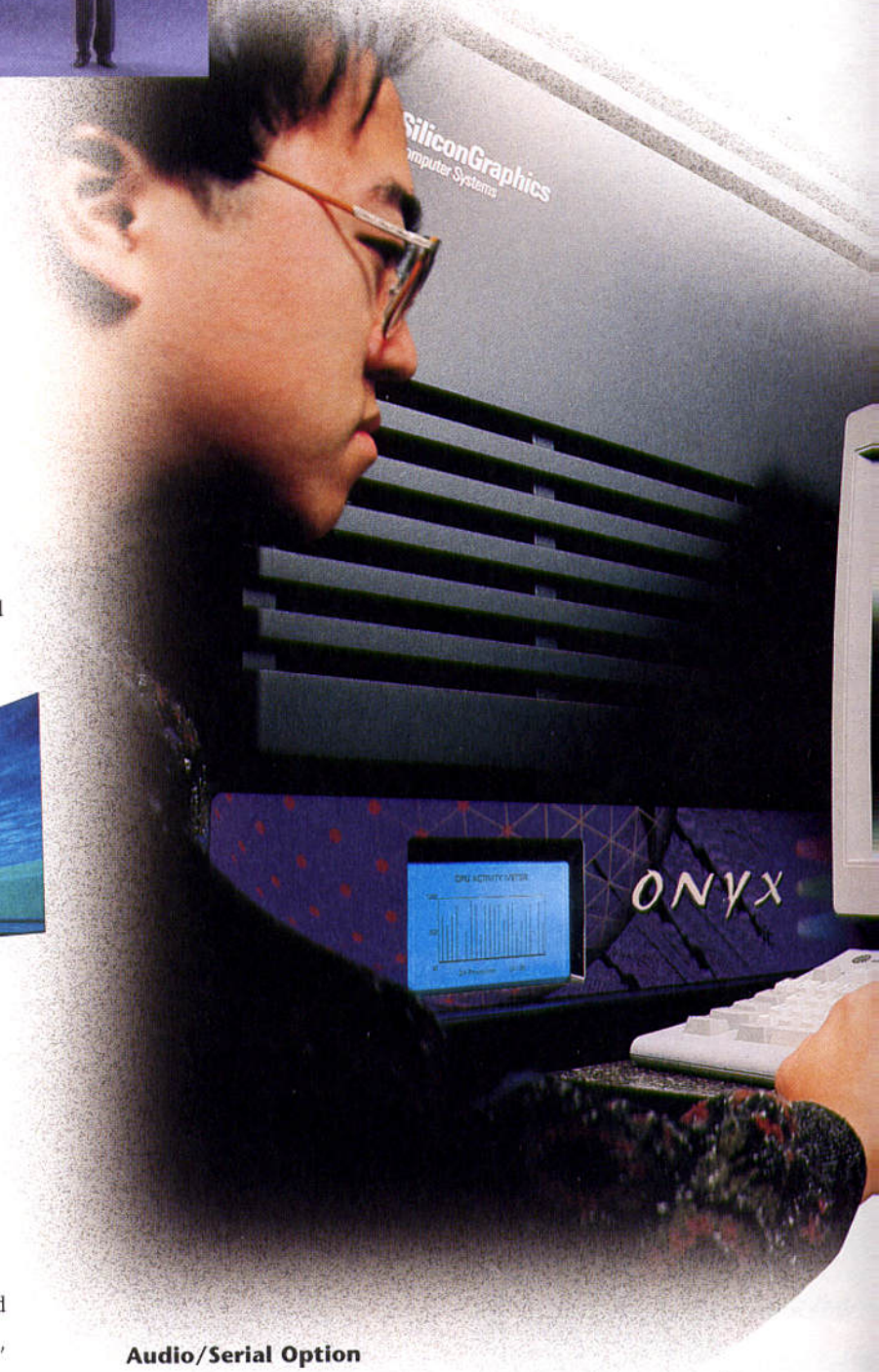
Both Onyx InfiniteReality and RealityEngine^2 systems provide multiple output channels for applications such as visual simulation, entertainment, and virtual reality. In its base configuration, InfiniteReality comes equipped with two programmable output channels designed right into its Display Generator board (DG4-2).



The multi-channel display generator for Onyx InfiniteReality permits users to drive up to eight simultaneous independent displays

This board converts digital information stored in the graphics frame buffer into a variety of multiple analog video signals—or channels—which can then be displayed on additional monitors, head-mounted displays (HMDs), or projection devices. An optional configuration (DG4-8) provides you with up to eight display channels.

RealityEngine^2 can drive up to six independent channels per graphics pipeline using its Multi-Channel Option (MCO).



Audio/Serial Option

The Audio/Serial Option provides both professional-quality audio processing and six high-speed asynchronous serial ports for connection to highly interactive devices, including tablets, VR equipment, and motion tracking hardware. The audio component lets you record, process, synthesize, and play four channels of 16-bit 48KHz audio signals. As an audio input source for the Silicon Graphics audio library, this option suits visual simulation applications or audio processing for film and video editing.

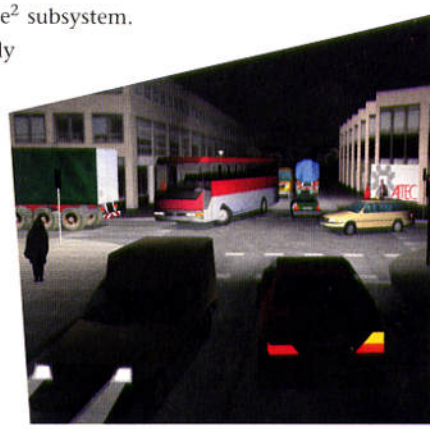
OpenGL®

Included in the IRIS® Development Option, the industry-standard OpenGL environment facilitates the development of InfiniteReality graphics applications on a variety of hardware platforms with different operating and window systems. OpenGL includes operators for geometric and raster primitives, viewing and modeling transformations, and many other graphics functions.

Real-time digital special effects processing

IRIS Performer™

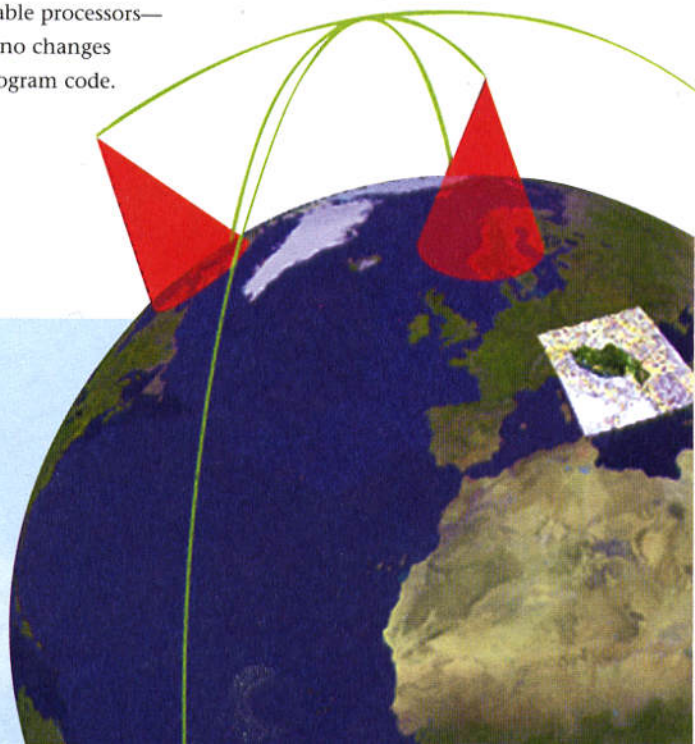
The IRIS Performer software development environment provides high-level support and advanced image-generation functions for real-time, interactive graphics applications. The inner core of IRIS Performer is a high-performance rendering executive. The outer interface simplifies access to the optimized rendering techniques that let programmers get the most out of the InfiniteReality and RealityEngine^2 subsystem. IRIS Performer also automatically manages multiple CPUs for even faster graphics performance. REACT™, a set of extensions to the IRIX operating environment, includes the REACTPro scheduler for achieving fast, deterministic execution on Onyx platforms.

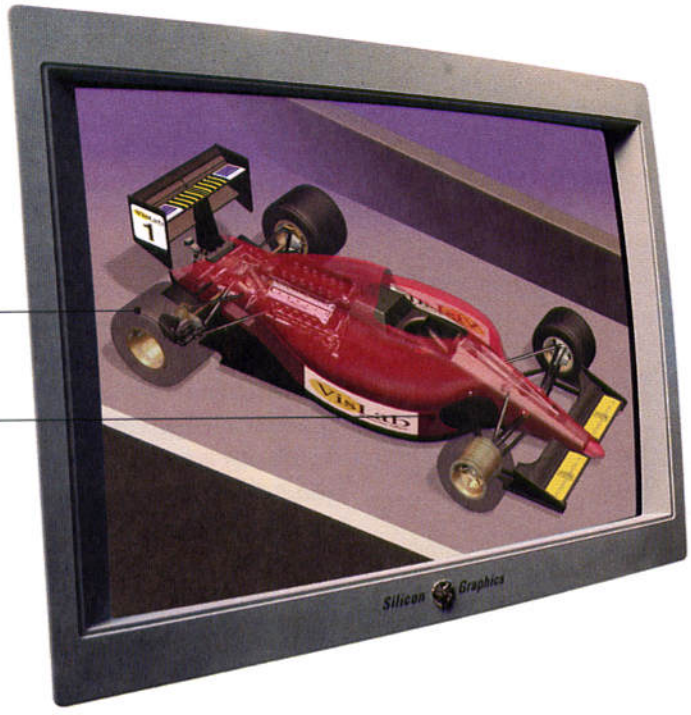


Realistic night scenes

ImageVision Library®

The object-oriented, extensible ImageVision Library (IL) toolkit simplifies creating and displaying images, and accelerates 2D image processing on Onyx platforms. Its core functions include optimized implementations for high-performance color conversion, arithmetic functions, radiometric and geometric transforms, statistics, spatial and non-spatial domain transforms, and edge, line, and spot detection. The IL toolkit takes advantage of all available processors—with no changes to program code.





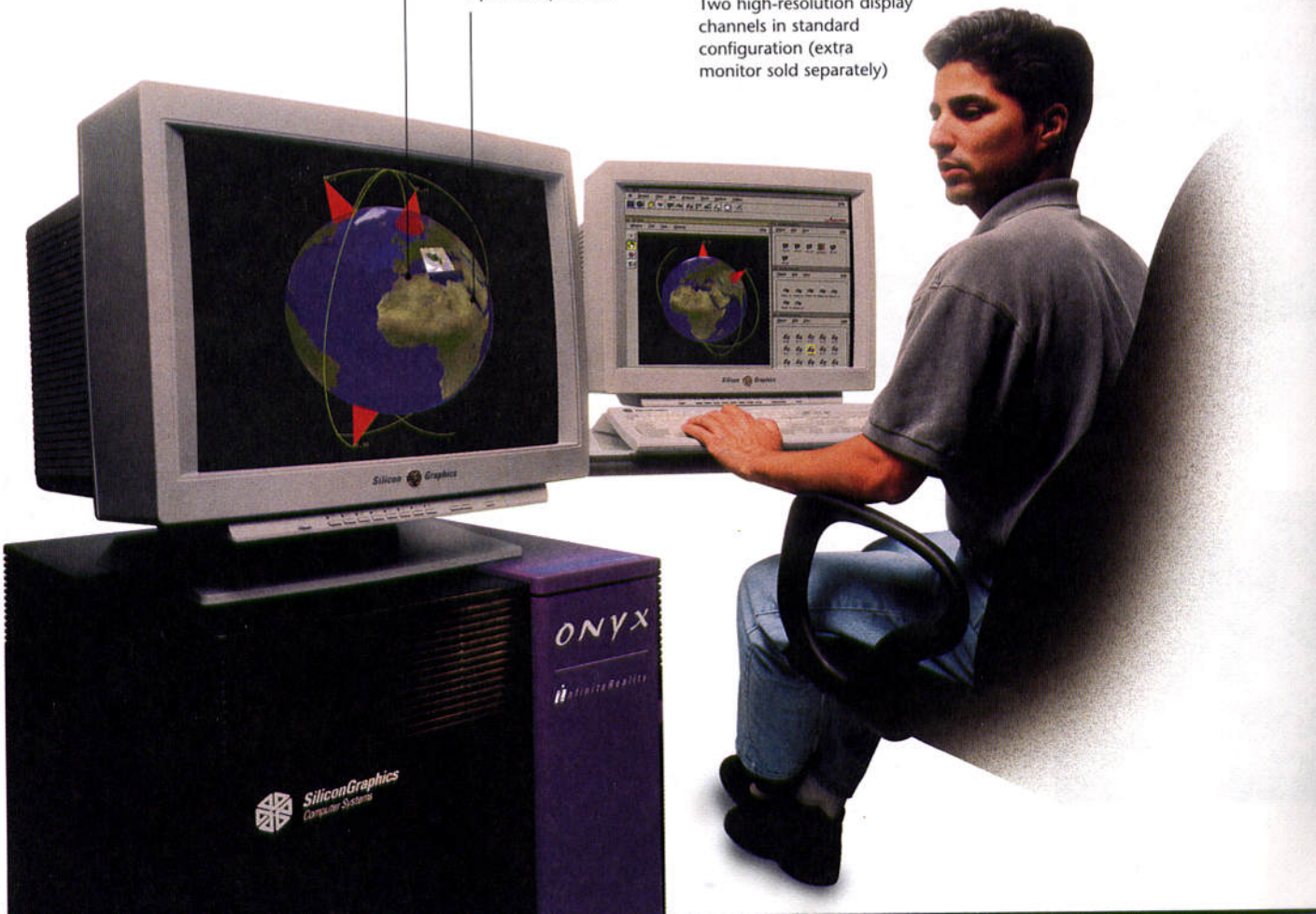
Alpha blending for creating transparent objects

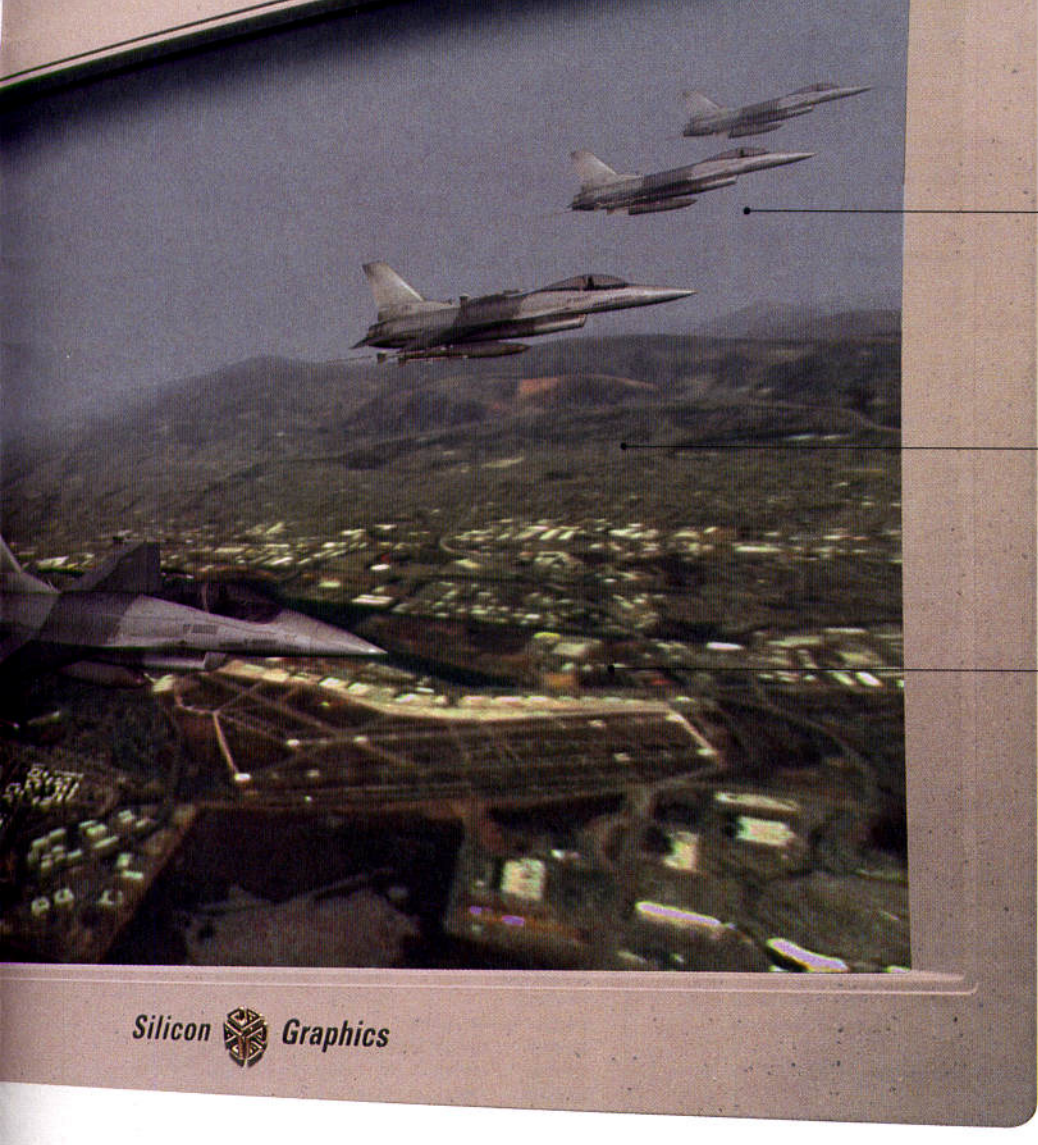
Trilinear MIP-mapped texturing with multisample anti-aliasing for photo-realistic scenes

Fast texture-download rates and accelerated image processing for real-time imaging

Full 12-bit processing of red, green, blue, and alpha components

Two high-resolution display channels in standard configuration (extra monitor sold separately)





Bilinear filtered video resizing and frame buffer resizing designed for guaranteed frame rates

Terrain level-of-detail management for efficient geometry processing

Geospecific texturing for realistic training environments

High-quality textured pixel processing for photo-realistic environments

Scenes updated at 60 frames per second

Onyx Technical *Specifications*

Platform:

	i-Station Reality Station		Onyx		POWER Onyx
Processor Data					
Type	MIPS R4400 250MHz MIPS R10000		MIPS R4400 250MHz or MIPS R10000		MIPS R8000 90MHz
Quantity	1		2–24		1–12
Primary Cache	R4400	R10000	R4400	R10000	
Instruction	16KB	32KB	16KB	32KB	16KB
Data	16KB	32KB	16KB	32KB	16KB
Additional Cache	1MB per processor		4MB per R4400 1MB per R10000		4MB per processor
	R4400	R10000	R4400	R10000	R8000
SPECint92	132	TBD	180	TBD	132.2
SPECfp92	139	TBD	177	TBD	396
Memory	64MB to 2GB 1- or 2-way interleaving, ECC protected		64MB to 16GB 1- to 8-way interleaving, ECC protected		64MB to 16GB 1- to 8-way interleaving, ECC protected
Graphics					
InfiniteReality	deskside only§		deskside and rack		n/a
RealityEngine²	deskside only		deskside and rack		deskside and rack
Operating System	IRIX 6		IRIX 6		IRIX 6

Graphics:

	InfiniteReality**	*i*-Station**	RealityEngine²
Anti-aliased vectors/sec	7.4M	TBD	2.0M
Triangles/sec	11M	TBD	1.8M
Pixel Fill, smooth, Z	224M to >800M	224M to >400M	90M to 360M
Pixel Fill, textured, AA	194M to >750M	194M to >380M	55M to 230M
Trilinear Interpolations/sec	>200M to >800M	>200M to >400M	40M to 160M
Convolutions 5x5 separable	TBD	TBD	20M
24-bit floating-point Z	yes	yes	n/a
32-bit integer Z	n/a	n/a	yes
Color	48-bit RGBA	48-bit RGBA	48-bit RGBA
Color Planes	192	192	192
Overlay/Underlay planes	16/0	16/0	8
Max bits/pixel	256–1024	256–1024	256–1024
Texture Memory	16 or 64MB	16 or 64MB	4 or 16MB
Frame Buffer Size	80 to 320MB	80 to 160MB	40 to 160MB
Display	VGA to HDTV non-interlaced	VGA to HDTV non-interlaced	VGA to 1600x1200 non-interlaced
Standard number of display channels	2	2	1

System Bus

Bandwidth	1.2GB/sec, parity protected
Size	256-bit wide data path 40-bit wide physical address path

High-Speed I/O Subsystem

Bus Type	SGI HIO bus
Bandwidth	320MB/sec per HIO bus
No. of Buses	1 to 4
No. of Slots	1 to 8

Industry-Standard I/O Subsystem

Bus Type	VME64 bus
Bandwidth	50MB/sec per VME64 bus
No. of Buses	1 to 5
No. of Slots	3 to 24

Mass Storage

Interfaces	Up to 32 SCSI-2 channels
Protocols	SCSI-2, Fast/Wide, single-ended or differential
Max. Bandwidth	20MB/sec per channel
Device Capacity	2GB or 4.3GB, formatted

Removable Media

SCSI Devices	CD-ROM, DAT, 8mm tape drive, 1/4" cartridge tape

Communications

Integrated Serial I/O	Up to 16 serial ports Ethernet, SCSI-2
Integrated Parallel I/O	Up to 4 parallel ports
VME Controllers	Ethernet, FDDI
SGI HIO Controllers	FDDI, HiPPI, SCSI-2, ATM, Audio/Serial Option

Dimensions and Weights

Rack Chassis	
Dimensions	Height: 62.3" Width: 27" Depth: 48"
Net Weight	400 lbs (181 kg)
Deskside Chassis	
Dimensions	Height: 25.2" Width: 20.5" Depth: 32"
Net Weight	160 lbs (72.6 kg)

Environmental (Non-Operating)

Temperature	-20 to +60 C
Humidity	10% to 95% non-condensing
Altitude	40,000 MSL

Environmental (Operating)

Temperature	+5 to +35 C
Humidity	10% to 80% non-condensing
Altitude	10,000 MSL
Noise	65 dBa

Electrical and Power

Voltage–Deskside	110-230 VAC 1 Phase
Voltage–Rack	208-230 VAC 1 Phase
Voltage–Rack	208 VAC 3 Phase U.S.
Voltage–Rack	400 VAC 3 Phase Europe
Frequency	50/60Hz
Electrical Service and Type	
Deskside	120 VAC @ 20A (1 Phase) Type NEMA5-20R
Deskside	208 VAC @ 20A (1 Phase) Type NEMA6-20R
Deskside	230 VAC @ 16A (1 Phase) Type dependent on country
Rack	208 VAC @ 30A (1 Phase) Type L6-30R
Rack	230 VAC @ 32A (1 Phase) Type dependent on country
Rack*	208 VAC @ 30A (3 Phase, 4 Wire) Type NEMA L15-30R
Rack*	400 VAC @ 32A (3 Phase, 5 Wire) Type IEC 309

§Entry-level version

**With graphics or VME expansion cage*

***Preliminary*

SiliconGraphics
Computer Systems

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